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16. An Agenda for Science Education for Gifted Learners

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The authors of the preceding Chapters have considerable experience in science teaching, supporting and developing science teachers, working with the gifted in school and out-of-school contexts, and carrying out research into aspects of teaching and learning science. Collectively these chapters offer considerable advice and insight into both the nature of giftedness in science and beyond, and into the kinds of good practice in science education that will support and challenge the most able learners. We have a good deal of understanding of what good science teaching and effective science learning activities might be. We have some very useful lists of indicators of giftedness, and some well-informed thinking about how these characteristics are best interpreted, demonstrated and developed in science. We know what gifted science education provision sometimes looks like (if often outside of the normal curriculum), and we are fairly confident that we understand what teachers should be setting out to do in order to stretch the most able within the context of science lessons. I think this book does represent 'the state of the art' in terms of 'science education for gifted learners'.

The next steps

However, there is little room for complacency. It is also clear from the various contributions that:

- Official policy and guidance on identifying and providing for the gifted is often confused and impractical;
- Teachers often lack skills and training to recognise high potential (especially when co-existing with learning difficulties or disaffection);
- Institutional and curriculum contexts may often work against teachers following the best-current advice offered in this book;
- Research into exactly how gifted students can and do respond when teachers are able to implement the type of approaches recommended here, especially within the context of normal science classes, is needed.

We suspect that, at the present time, only a minority of teachers would be comfortable adopting the ideas here directly into their practice. Courses of initial teacher preparation (like the science curriculum they prepare new entrants to teach) are crowded, and there are many other priorities for professional development. Without their *own* learning being scaffolded (by courses, by opportunities to explore ideas in supportive institutional contexts, by constructive feedback and evaluation from trusted mentors) many science teachers may feel uneasy with some of the suggestions we make here (even those which seem to mirror curriculum and other developments): open-ended projects; making student questions central; providing choices of context, activity and modes of working; discussing issues with no scientific right answers; giving students more responsibility for their learning and its assessment; metacognitive modelling…

In the UK, a new upper secondary level curriculum is just being introduced (for 14-16 year olds): one that supposedly offers more flexibility, and potentially demands less learning of isolated material. This *should* free up teachers to follow more of the advice in this book. However, as Richard Coll points out (in Chapter 5) changes in curriculum are not in themselves enough to enable teachers to make desirable changes in practice. Teachers are still constrained by examination syllabuses that prepare students for high status school leaving examinations at 16. A review of the lower secondary science curriculum is expected to lead to similar curricular changes for 11-14 years olds: but again teaching is currently channeled and constrained by the National Tests taken by 14 year olds. A real test of any liberalisation of curriculum will be the nature of what is assessed. If the focus of assessment clearly encompasses higher-level cognition, demonstrating creativity, scientific intuition, effective argumentation, emotional and social intelligence, and so forth, then teachers will feel ‘safer’ in looking to challenge learners in the ways we recommend in this book. If the focus remains of reproducing the curriculum models and applying them to a range of standard examples and contexts, then a great opportunity will be lost.

Therefore, whilst I would whole-heatedly recommend the advice and guidance in this book to teachers, as representing the current state of knowledge, there is a lot more that we need to know if we are going to support teachers in carrying out our recommendations, and – in particular – judging whether they are offering an optimal level of challenge to the most able learners in science classes. It seems appropriate therefore to end the book, not with self-congratulations on a job well done, but rather with a look to what *more* is needed to better meet the special education needs of the most able in science.

In particular, we need more focused research on effective science teaching for the gifted, but this needs to be research that effectively links to (explores, and informs) practice. Indeed we need a cyclic process, similar to that Alan West discusses (in Chapter 10 in relation to student investigative work), to inform developments in science education for gifted learners. Ideally, such research would form the focus of well-funded, large-scale projects – carried out by experienced researchers sponsored by research councils and other august bodies. More commonly, research in science education depends upon the individual projects of masters and doctoral level students, and facilitating small-scale action research in individual classrooms and schools.

Yet even piecemeal research, carried out by lone graduate students and classroom teachers, has the potential to contribute as part of a coherent research programme. Indeed, there may even be a case for suggesting that we can do more to change teacher’s classroom practice through a coordinated programme of small-scale action research.

An integrated model for researching practice

As earlier Chapters have shown, there is already a considerable body of thinking to inform teaching science to the gifted – the 'conceptual frameworks' are already in place. What is lacking is a sufficient body of research into what this actually means, and potentially *can* mean, in various classroom contexts - to inform teacher education (initial and continuing), to inform curriculum development, and to inform education policies and wider practice.

In other words, we already have an agenda of ideas and principles that teachers can adopt. But we lack sufficient exemplification to show new and developing teachers what this can reasonably mean for their classroom teaching:

- research that would inform effective teacher education, by showing teachers *how to adopt and apply* these principles, and *how to evaluate* the outcomes;
- research of sufficient standing within the profession to allow the science education community, and those learned scientific bodies concerned about the future of science education, to confidently lobby for curriculum and assessment policies that support and facilitate the types of practices that challenge and develop our learners.

We need to be informed by more of the types of case studies of innovative and thoughtful practice that John Gilbert and Matthew Newberry report from the Cams Hill Science Consortium (CHSC). A context such as CHSC offers a comfort zone where teachers feel they do have permission to be innovative, and are supported by informed but constructive peer evaluation. This type of work demonstrates theory-in-action: what teachers can make of our recommendations in the context of real classes of real students whilst working in real schools. We need to know how teachers can be supported to implement best practice in discussing socio-cultural issues (Chapter 10), and context-base courses (Chapter 11); how *all* science teachers can develop classroom dialogue along the lines of the best practice Phil Scott identifies (Chapter 8); how full-time teachers with full-time teaching loads can adopt our ideas about student questioning, challenging students through the nature of science, implementing authentic investigations (Chapters 9, 14, 13), etc., within the constraints of institutions and curriculum requirements.

This needs to be an iterative process: if such research can bring about even modest changes - in teacher education and development; in curriculum and assessment procedures; in institutional structures and official policies and guidance - then these changes also need to be researched to push the improvement cycle forward.

An agenda for research and development

I would like to close this book then, with just some of the foci that might structure the programme of ongoing research that will move our agenda forward:

- really engaging students' interests as well as intellects through context-based courses;
- finding ways to provide engagement in topics in depth and over extended periods – both in practically based and other types of science topic work;
- offering access to resources that support the development of scientific intuition;
- facilitating gifted students with learning difficulties to demonstrate potential through multi-modal teaching;
- adjusting the rhythm of types of classroom talk to differentiate for the most able learners;
- understanding the factors that lead to the best balance between working with similar gifted peers, and peer-tutoring in mixed groups to develop the most able;
- finding the optimal level of support when ceding responsibility for independence-in-learning and choice to gifted learners;
- challenging learners to reach their full potential without the kinds of labelling that can stigmatise, pressurise and exclude learners;
- adopting pedagogy to habitually demonstrate the process of modelling in action;
- adopting pedagogy to model scientific dialogue and argumentation;

- facilitating learning environments that are characterised as 'zones of low-conformity' and climates of enquiry that offer alternative solutions; tolerate and support constructive error; and encourage effective surprise – whilst offering a teaching environment that offers security for teachers ;
- encouraging mastery goals, and self-regulated learning, within the constraints of a prescribed curriculum;
- understanding what emotionally-intelligent science learning might be;
- how the 'categories of disagreement' model may be best developed as a planning and differentiation tool for teaching about socio-scientific issues to challenge the most able;
- developing the 'gifts' of all our learners, regardless of gender, culture, multiple exceptionalities etc.

These are just some examples based upon the various recommendations and key ideas identified in this book. Each of these, and other areas, can be better illuminated by careful research within authentic (especially 'typical' classroom) teaching and learning contexts. Research in these areas will help us refine what we understand by best meeting the needs of the most able in science; help us appreciate what is possible in practice; help us better evaluate when learners are really being challenged, engaged and developed towards the realisation of their potential to enjoy and succeed in school science and beyond.

Bon voyage

In the first Chapter, I set out to give an overview of the landscape that teachers might enter when looking to offer science education for gifted learners. In the Chapters that followed, we described some of the scenery that the teacher venturing into that landscape might look out for. We certainly need more cartographers to map out the detail of the various regions. In the meantime, we invite teachers to consider the present volume as at least offering a compass to guide you into the territory. In places you may need to 'watch your step', but for the benefit of your gifted learners we hope you will start the journey. Perhaps you may even document and share the experiences of your travels. The main thing, though, is at least to set off, confident that you are moving in the right direction. We recommend that teachers do what they can to adopt the recommendations in this book. After all, we certainly believe that science teachers, like their gifted learners, respond well to being engaged in challenging work that they believe is relevant, interesting and worthwhile.